



CARLO GAVAZZI SPACE SpA

AMS-02

Tipo Doc.: Doc. Type:	PROCEDURE	N° DRD: DRD N°:	NA
N° Doc.: Doc. N°:	AMS02-PR-CGS-004	Ediz.: 1 Issue:	Data: Date: AUG 2007
Titolo : U-TOF VIBRATION TEST PROCEDURE Title :			

	Nome & Funzione Name & Function	Firma Signature	Data Date
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Accettato da: Accepted by:			
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Gestione documenti: Data Management: -----			
Firma / Signature		Data / Date	File: AMS02-PR-CGS-004_is1.doc

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 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1 style="text-align: center;">AMS-02</h1> <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°</i> AMS02-PR-CGS-004 Ediz.: <i>Issue</i> : 1 Data: <i>Date</i> : AUG 2007 Pagina <i>Page</i> 2 di 34
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REGISTRAZIONE DELLE MODIFICA / CHANGE RECORD			
EDIZIONE <i>ISSUE</i>	DATA <i>DATE</i>	AUTORIZZAZIONE <i>CHANGE AUTHORITY</i>	OGGETTO DELLA MODIFICA E SEZIONI AFFETTE <i>REASON FOR CHANGE AND Affected SECTIONS</i>
1	AUG 2007		First Issue

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1 style="text-align: center;">AMS-02</h1>	U-TOF VIBRATION TEST PROCEDURE		N° Doc: Doc N°:	AMS02-PR-CGS-004	
		Ediz.: Issue:	1	Data: Date:	AUG 2007	
		Pagina Page	3	di of	34	

LISTA DELLE PAGINE VALIDE / LIST OF VALID PAGES									
PAGINA PAGE	EDIZIONE ISSUE	PAGINA PAGE	EDIZIONE ISSUE	PAGINA PAGE	EDIZIONE ISSUE	PAGINA PAGE	EDIZIONE ISSUE	PAGINA PAGE	EDIZIONE ISSUE
1 - 34	1								

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1>AMS-02</h1>	N° Doc: Doc N°: Ediz.: Issue: Pagina Page	AMS02-PR-CGS-004
	U-TOF VIBRATION TEST PROCEDURE		Data: Date: AUG 2007

TABLE OF CONTENT

1. SCOPE	6
2. DOCUMENTS.....	7
2.1 APPLICABLE DOCUMENTS	7
2.2 REFERENCE DOCUMENTS.....	7
3. ACRONYMS	8
4. MEASUREMENT ACCURACY	9
5. CONTROL TOLERANCE.....	9
6. TEST ARTICLE	10
7. TEST ARTICLE HOISTING FIXTURE	11
8. TEST CONFIGURATION	12
9. FACILITY DESCRIPTION	13
9.1 SHAKER CONTROL SYSTEM	13
9.2 SHAKER AND SLIDING TABLE	14
9.3 DATA EVALUATION.....	15
10. TEST FIXTURE	16
10.1 FIXTURE DESIGN	16
10.2 FIXTURE TEST	19
11. ACCELEROMETERS.....	20
12. INSTRUMENTATION PLAN	21
12.1 ACCELEROMETERS.....	21
13. INSTRUMENTATION, SPECIAL TOOLS AND TEST EQUIPMENT.....	26
14. TEST LEVELS.....	28
14.1 RESONANCE SEARCH LEVELS	28
14.2 RANDOM VIBRATION LEVELS.....	28
15. TEST PREDICTIONS AND NOTCHING APPROACH.....	30
15.1 NOTCHING PHILOSOPHY	30
15.2 NOTCHING FOR STRENGHT PURPOSES.....	31
15.3 NOTCHING FOR COMPONENTS SPECIFICATION	32
16. TEST CONDITIONS	33
17. TEST DATA SHEETS EXAMPLES.....	33
17.1 DATA SHEETS FILLING UP INSTRUCTIONS	33

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02 <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°:</i> AMS02-PR-CGS-004 Ediz.: 1 Data: AUG 2007 <i>Issue:</i> Pagina <i>Page:</i> 5 di 34
---	---	---

LIST OF TABLES

Tab. 6-1 U TOF envelope	10
Tab. 6-2 U TOF Mass budget.....	10
Tab. 10-1 INSTALLATION BOLTS AND TORQUES	18
Tab. 10-2 FIXTURE Mass budget (UTOF not included).....	18
Tab. 6-1 Measurement points table	25
Tab. 13-1 Instrument list.....	27
Tab. 14-1 Resonance search level.....	28
Tab. 14-2 UTOF MEFL Random spectrum FROM AD1.....	28
Tab. 15-1: notching logic flowchart RD1	30

LIST OF FIGURES

Fig. 6-1 U-TOF and test coordinate system.....	10
Fig. 7-1 UTOF hoisting device and hoisting points	11
Fig. 8-1 U TOF shaker test Configuration – Z axis	12
Fig. 8-2 U TOF sliding table test Configuration – X & Y axis	12
Fig. 10-1X-Y Fixture.....	16
Fig. 10-2 Z Fixture	17
Fig. 10-3 UTOF-fixture connection detail.....	17
Fig. 10-4 Fixture Z test configuration	Errore. Il segnalibro non è definito.
Fig. 10-5 Fixture XY test configuration	Errore. Il segnalibro non è definito.
Fig. 12-1 U-TOF qualification pilot and copilot view.....	21
Fig. 12-2 U-TOF qualification measurement points view on Brackets.....	22
Fig. 12-3 U-TOF qualification measurement points view on top panel.....	22
Fig. 12-4 U-TOF qualification measurement points view on lower panel	23
Fig. 12-5 U-TOF qualification internal measurement points view	23
Fig. 12-6 U-TOF qualification internal measurement points view	Errore. Il segnalibro non è definito.
Fig. 12-7 U-TOF qualification internal measurement points view	Errore. Il segnalibro non è definito.
Fig. 14-1 UTOF MEFL Random spectrum FROM AD1	29

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1>AMS-02</h1>	N° Doc: Doc N°: Ediz.: Issue: Pagina Page	AMS02-PR-CGS-004
	U-TOF VIBRATION TEST PROCEDURE		Data: Date: AUG 2007

1. SCOPE

This document is prepared by CGS in support to INFN (BO) as guideline for the technical issues related to U-TOF Flight model (FM) vibration test execution, in particular:

- Facility requirements for measurement accuracy and control tolerance.
- Fixture design and test description and definition of UTOF integration process into the fixture.
- Test configuration (sliding table and shaker).
- Instrumentation plan description.
- Selected Facility description.

CGS responsibility during the test shall be therefore limited to technical advisory, being CGS involved in the UTOF design verification activities, and technical evaluation of the test results.

All PA\QA activities and responsibilities related to test execution and reporting shall be taken by INFN(BO).

The objective of the test setup to be performed according to this procedure is :

- to measure the UTOF first frequency.
- To provide a workmanship verification for the U-TOF.

U-TOF verification followed in this procedure, is**:

- Upper TOF First mode hardmounted (FEA) < 50 Hz (Current First Mode hardmounted(FEA) 43.95 Hz First mode is a drum mode, Current First Mode fixture mounted(FEA) is 33.62 Hz) **verified by frequency identification and measurement channels comparison with FEM predictions**
- Upper TOF Random Vibration to **MEFL (SVP Table 15.1)** axes with sine sweep test before & after (notching is foreseen to avoid overtesting of PMTs)

The test shall be successfully performed if the following performances shall be measured:

- The measured first mode shall be > 33.62 Hz for UTOF mounted on fixture .
- FEM model of the fixture well correlated with the fixture calibration test results.
- The UTOF performances shall not be degraded by the vibration environment.

Technical information on the test setup are collected in this document and on the INFN test sequence and shall be referenced during test execution.

The test results shall be collected in a Facility Test Report prepared by SERMS and included in the final test report by INFN.

***This verification approach is based on the contents of RD3, reported hereafter for information only:*

- Upper TOF First mode hardmounted< 50 Hz (Current First Mode 44.9 Hz First mode is a drum mode) Sine Sweep Test of TOF system will be performed.
- **Upper TOF Optional Verification for mission success (Random Vibration to MWL (SVP Table 15.2) 6.8 Grms Level in X, Y, & Z axes with sine sweep test before & after).**

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1 style="text-align: center;">AMS-02</h1> <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: Doc N°:	AMS02-PR-CGS-004	
		Ediz.: Issue:	1	Data: Date: AUG 2007
		Pagina Page	7	di of 34

2. DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents, in the valid latest issue formally agreed with the Agency, form a part of this specification to the extent specified herein. Documents referenced in the following specifications, standards, publications and procedures are also a part of this specification and are applicable to the extent specified in the text to meet the requirements of this document.

AD #	Doc Number	Issue	Date	Rev	Title
NA					

2.2 REFERENCE DOCUMENTS

#	Doc Number	Issue	Date	Rev	Title
RD 1	RICSYS-RP-CGS-013_ls1	1	29-06-04		UPPER TOF STRUCTURAL ANALYSYS REPORT
RD 2	AMS02-TN-CGS-021	1	Aug 2007		UPPER TOF VIBRATION TEST PREDICTION
RD 3	JSC 28792,		August, 2003	Rev. C	Alpha Magnetic Spectrometer – 02 Structural Verification Plan for the Space Transportation System and the International Space Station

 CARLO GAVAZZI SPACE SpA	<h1 style="text-align: center;">AMS-02</h1>	N° Doc: <i>Doc N°</i> AMS02-PR-CGS-004 Ediz.: <i>Issue</i> : 1 Data: <i>Date</i> : AUG 2007 Pagina <i>Page</i> 8 di <i>of</i> 34
U-TOF VIBRATION TEST PROCEDURE		

3. ACRONYMS

C.I.	Configuration Item. Also called Part Number (P/N)
CGS	Carlo Gavazzi Space
CP	Control Point
ICD	Interface Control Drawing
INFN(BO)	INFN Bologna institute
FEM	Finite Element Method/Model
FEA	Finite Element Analysis
MP	Measurement Point
NA	Not Applicable
NCR	Non Conformance Report
P/N	Part Number. Also called Configuration Item C.I.
PA	Product Assurance
PVS	Procedure Variation Sheet
PSD	Power Spectral Density
QA	Quality Assurance
RV	Random Vibration
S/N	Serial Number
SERMS	SERMS Vibration test Facility in Perugia
UUT	Unit Under Test
TOF	Time Of Flight
UTOF	Upper Time Of Flight

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02	N° Doc: Doc N°: Ediz.: Issue: Pagina Page	AMS02-PR-CGS-004
	U-TOF VIBRATION TEST PROCEDURE		Data: Date: AUG 2007

4. MEASUREMENT ACCURACY

Test parameter tolerances shall be as follows:

Resonance search.

sweep rate = 2 oct/min $\pm 5\%$. (1 sweep-up and down), amplitude g

High level sine vibration.

frequency: $\pm 2\%$

excitation acceleration: $\pm 0.3g$

Resonance search.

frequency: $\pm 2\%$

excitation acceleration: $\pm 0.1g$

Random vibration.

frequency: $\pm 2\%$

power spectral density:

- | | |
|---|--------------|
| - 20 to 500 Hz (filter bandwidth 25 Hz or narrower) | ± 1.5 dB |
| - 500 to 2000 Hz | ± 3.0 dB |
| - Overall g_{RMS} | ± 1.5 dB |

5. CONTROL TOLERANCE

The transmissibility characteristic of the rigid fixture and the number of control channels used will guarantee that the controlled input vibration level is transmitted from the exciter to the unit interface without relevant amplification/degradation (less than 3dB between 5 and 500 Hz and ± 6 dB between 500 and 2000 dB) Provided that the cumulative bandwidth that exceeds ± 3 dB, does not exceed 300 Hz) with respect to the nominal input.

No relevant discrepancies between the control signal and the different control points shall be present in case of multi-point control.

Cross talks shall not exceed the input.

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02 <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°:</i> Ediz.: <i>Issue:</i> Pagina <i>Page</i>	AMS02-PR-CGS-004 1 Data: <i>Date:</i> AUG 2007 10 di <i>of</i> 34
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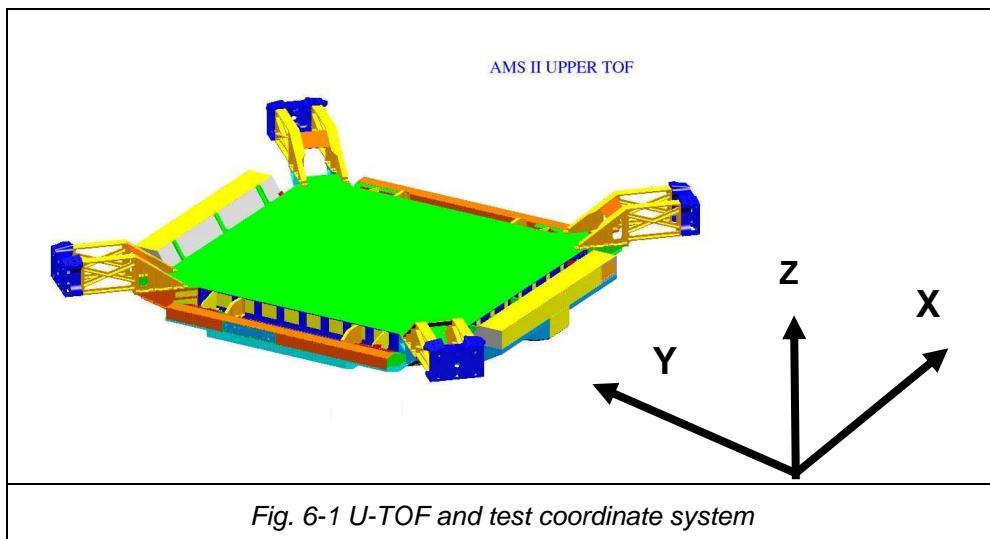
6. TEST ARTICLE

The test article consists of the UTOF assy. The following table shall be compiled during test :

MODEL	ITEM	C.I.	Part number	S/N	NOTES
FM	AMS UPPER TOF FM		AMS TOF UT	na	

The UTOF shall be tested without external harness during vibration.

Following figure shows the UUT in test configuration and the test reference coordinate system.



The maximum envelope and the mass budget is presented in the following tables:

UTOF ENVELOPE	
Direction	Envelope (incl. rods) [mm]
X	2030
Y	2030
Z	330

Tab. 6-1 U TOF envelope

UTOF MASS BUDGET (TEST CONFIG.)	
ITEM	Estimated weight [kg]
TOTAL	124.4

Tab. 6-2 U TOF Mass budget



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:
Doc N°:**AMS02-PR-CGS-004**Ediz.:
Issue:**1**Data:
Date:**AUG 2007**Pagina
Page**11**di
of**34**

7. TEST ARTICLE HOISTING FIXTURE

The U-TOF main part shall be lifted from the transport container using the tool showed in the next picture.

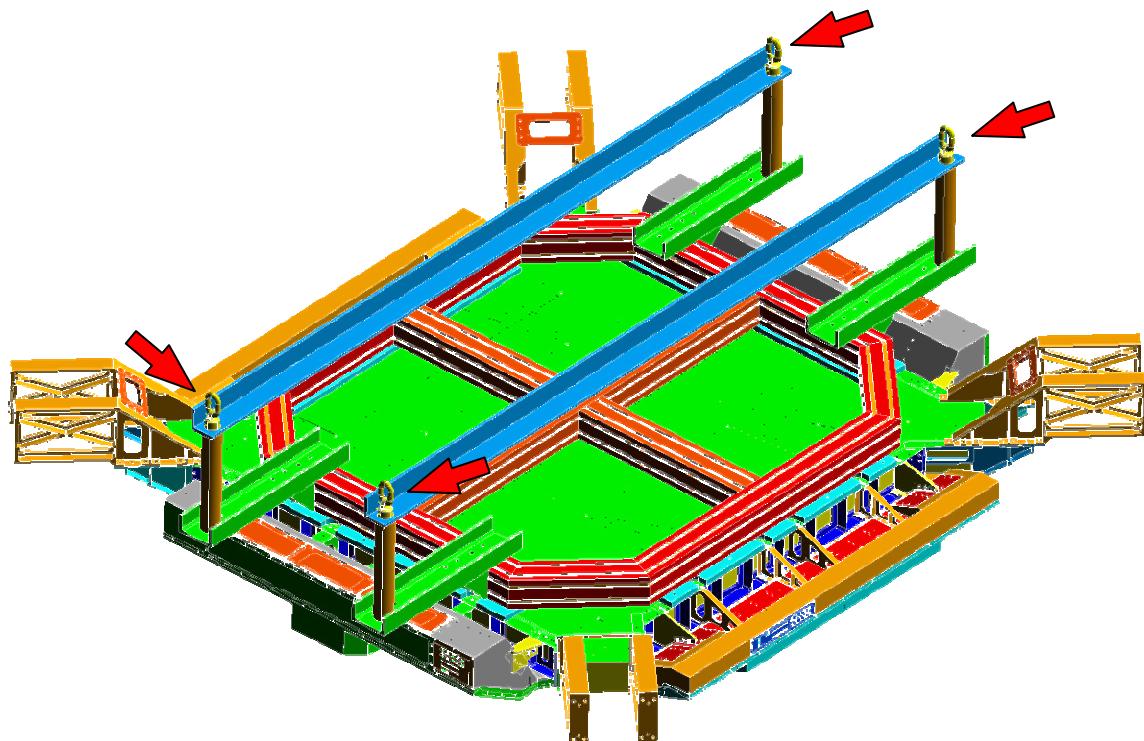


Fig. 7-1 UTOF hoisting device and hoisting points

Then the U-TOF shall be positioned on the fixture with the hoisting device and the U-TOF bracket shall be fixed to the fixture interface.



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:

Doc N°:

AMS02-PR-CGS-004

Ediz.:

Issue:

1

Data:
Date: AUG 2007

Pagina

Page

12

di
of 34

8. TEST CONFIGURATION

Two different configuration are foreseen, one for shaker and one for sliding table:

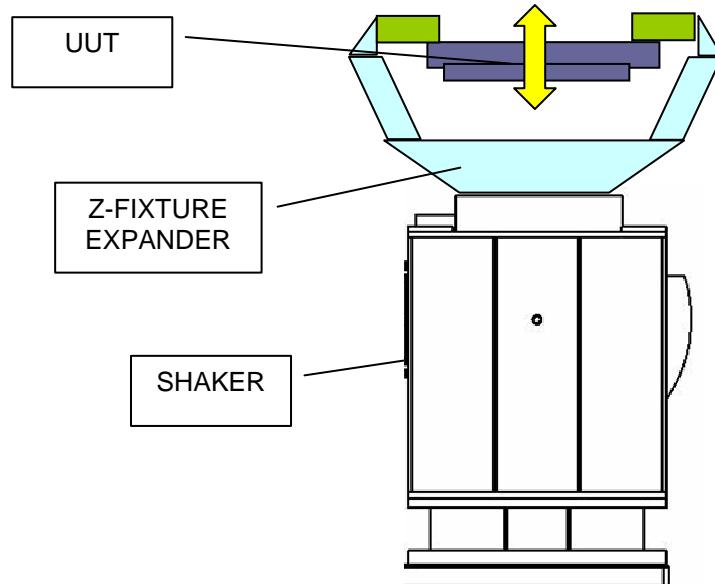


Fig. 8-1 U TOF shaker test Configuration – Z axis

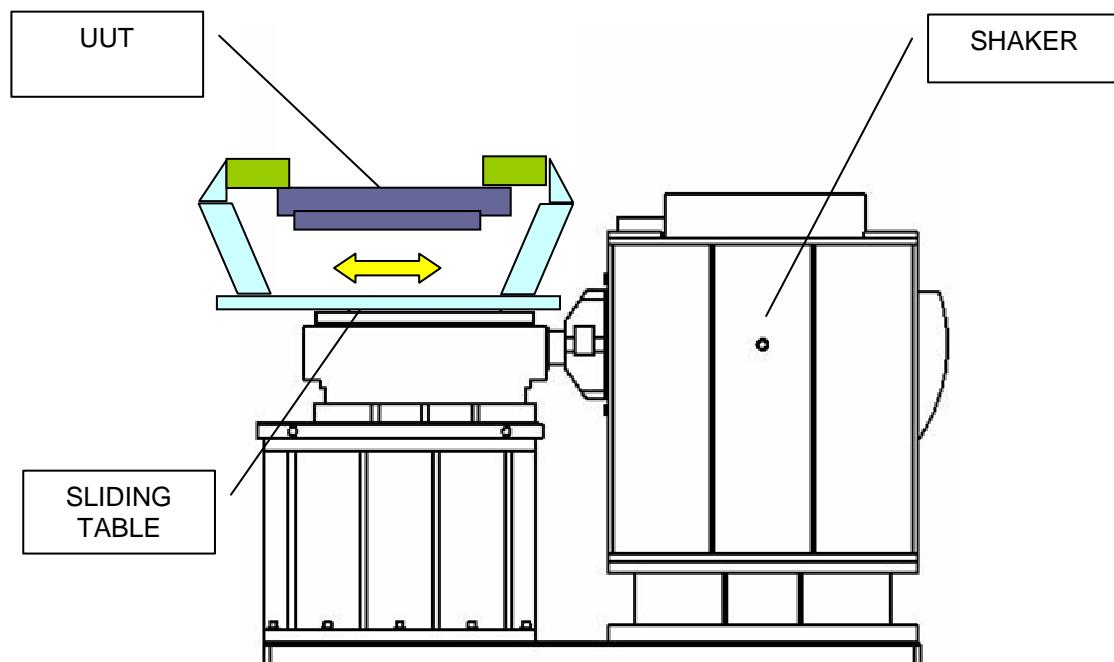


Fig. 8-2 U TOF sliding table test Configuration – X & Y axis

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1>AMS-02</h1>	N° Doc: Doc N°: AMS02-PR-CGS-004 Ediz.: 1 Data: AUG 2007 Issue: Pagina Page 13 di 34
	U-TOF VIBRATION TEST PROCEDURE	

9. FACILITY DESCRIPTION

The test shall be performed in SERMS facility:

SERMS

(laboratorio per lo Studio degli Effetti delle Radiazioni sui Materiali per lo Spazio)

Via Pentima Bassa, 21 05100 Terni

tel. +39 0744 492913

fax +39 0744 492913

9.1 SHAKER CONTROL SYSTEM

Sistema di Controllo

Spectral Dynamics

Belotti Sistemi
Via F.III Bandiera, 8 – 20068 Peschiera Borromeo (MI)
Tel. 02.55.30.82.23 – Fax 02.55.30.31.55
E-mail: belotti.sistemi@iol.it
Web site: www.belotti-online.it
Controller: Jaguar SD 2560 – 38ch
Workstation: Sun Ultra 10
Software: Sine, Random

JAGUAR 2570 ACP 38 channel-1 output system

Mod.number: 2570-9700-2
Serial number: 2570-1268
Board: 2560-2570

Configurazione attuale 38ch di acquisizione
1 uscita drive
1 uscita COLA

Input channel

Single ended pseudo differential
10 Ω to system ground
BNC connectors

Impedenza d'ingresso >1MΩ shunt <120pF
Input coupling AC, DC, ICP

Amplificazione di ingresso programmabile:
Random, Shock, Signal Analaysis 10V÷27mV in 3dB steps (18 ranges)

Sweep Sine 10V÷12,5mV in 1dB steps (56 ranges)

Cross-talk fra i canali (0÷20kHz) ≤ -90dB
Channel matching

Aampiezza: ≤ ±0,25 dB
Fase: ≤ ±1° (DC ± 20kHz)
≤ ±2,5° (20kHz ± 40kHz)

Segnale max in ingresso senza danneggiamento: ± 35V picco

Output channel

Drive variabile
DAC 16 bit (204.8 samples/sec)
Output range 0±96 dB in 0.05 dB steps
Max output ± 10 V picco
Impedenza d'uscita 60 Ω

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1>AMS-02</h1>	N° Doc: <i>Doc N°</i> AMS02-PR-CGS-004
	U-TOF VIBRATION TEST PROCEDURE	Ediz.: <i>Issue</i> 1

Data:
Date:
AUG 2007

Pagina
Page
14 di
34

9.2 SHAKER AND SLIDING TABLE

For RV testing a 80 KN shaker and sliding table system shall be used.
The shaker and sliding table characteristics are annexed hereafter:

Vibratore Elettrodinamico Ling Electronics, Inc.

4890 E. La Palma Ave.
Anaheim, CA 92807
Toll Free: 800-321-1781
Phone: (714)779-1900
Fax: (714)777-9173
1212E - Solid State Amplifier
C335 Vibration Exciter-modello 2016

Caratteristiche meccaniche

Carico massimo verticale	907,0 kg	8,90 kN	2000 Pounds
Carico massimo laterale	453,5 kg	4,45 kN	1000 Pounds
Carico massimo a 10g	852 kg	9,36 kN	1880 Pounds
Carico massimo a 20g	398,6 Kg	3,91 kN	880 Pounds
Carico massimo a 100g	36,24 Kg	0,356 kN	80 Pounds

Nota: tali valori sono relativi al solo shaker, per test in verticale e orizzontale; nel nostro caso il test orizzontale si differenzia dal caso precedente perché il carico non grava più sulla testa dello shaker, la quale imprime solo il moto.

Range di frequenza effettivo di lavoro 5-3000 Hz

Frequenze Naturali

Verticale: < 3 Hz
Orizzontale: < 2 Hz

Fondamentale nominale (bare table) 2,275 Hz

Performance

Sine sweep	20000 pounds	88,8 kN peak vector
Random	16000 pounds	71 kN rms
Velocità	177,8 cm/sec	70 inch/sec
Spostamento (continuo)	38,1 mm	1,50 inch
Spostamento (shock)	51 mm	2 inch
Overtravel limitation	53,1 mm	2,1 inch
Accelerazione (bare table)	150g	

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02 <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°</i> : AMS02-PR-CGS-004 Ediz.: 1 Data: AUG 2007 <i>Issue:</i> Pagina <i>Page</i> : 15 di 34
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Tavole Vibranti

Team Corporation UK Ltd.

P.O. Box 79
 St. Leonard's on Sea TN37 7WX
 United Kingdom
 Tel: +44 (0) 1424-777004
 Fax: +44 (0) 1424-777005
www.teamcorporation.com

T- Film Slip Table System 2,1x2,1m working surface
 Slip Plate 1x1m working surface

Tavola grande

Dimensioni: 2,1X2,1 m;

Matrice di ancoraggio: matrice 250mm (M10X1,5) vedi schemi seguenti;

Performance:

Accelerazione massima a vuoto: 7g
 Range di frequenza: 5-1000 Hz

$$\text{Sine sweep: } a = \frac{20000}{2840 + \text{peso oggetto}}$$

$$\text{Random: } a = \frac{16000 \text{ (lb)}}{2840 + \text{peso oggetto}}$$

nota: il valore di 2840 lb è comprensivo del peso della tavola, sommato a quello della travel-bare interna allo shaker e del giunto di ancoraggio tra shaker e tavola;

Tavola piccola

Dimensioni: 1X1 m;

Matrice di ancoraggio: matrice 250mm (M10X1,5) vedi schemi seguenti;

Performance:

Accelerazione massima a vuoto: 22,8g
 Range di frequenza: 5-2000 Hz

$$\text{a = } \frac{20000}{875 + \text{peso oggetto}}$$

nota: il valore di 2840 lb è comprensivo del peso della tavola, sommato a quello della travel-bare interna allo shaker e del giunto di ancoraggio tra shaker e tavola;

9.3 DATA EVALUATION

The facility shall provide after each test run the frequency dependent data in printed form to allow data evaluation. Under request it will be possible to compare plots from different runs on monitor and print the compared curves before to proceed to the next run

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1>AMS-02</h1>	N° Doc: <i>Doc N°</i> : AMS02-PR-CGS-004 Ediz.: <i>Issue</i> : 1 Data: <i>Date</i> : AUG 2007 Pagina <i>Page</i> : 16 di <i>of</i> 34
U-TOF VIBRATION TEST PROCEDURE		

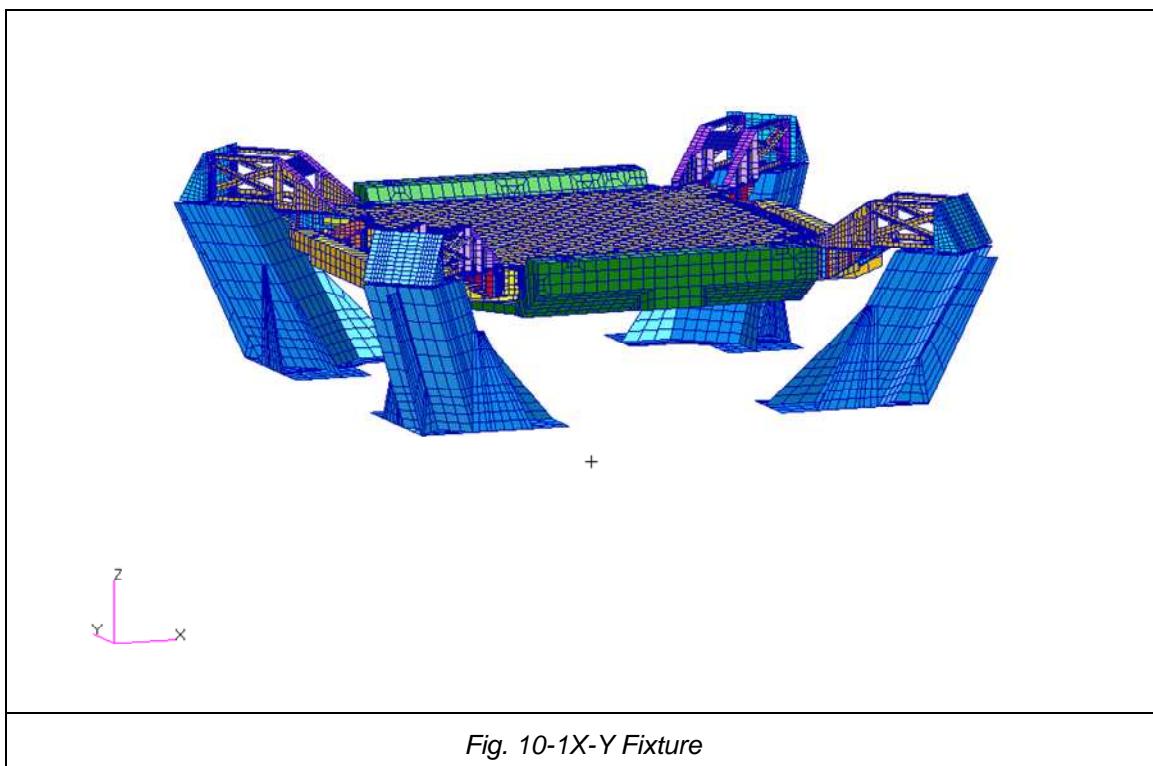
10. TEST FIXTURE

10.1 FIXTURE DESIGN

Fixture manufactured by SERMS facility shall provide a fixation patterns to the facility equipment and to the UUT. The fixture dynamic behavior shall guarantee:

- Successful identification of the first resonance search of the U-TOF.
- Control the vibration levels at UUT interface within the required tolerances.
- The fixture shall be able to withstand all the applicable integration and test loads.

Two different fixtures shall be used, one for in plane (X-Y) vibration and one (Z) vibration In the following figure the fixtures are showed.





CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:
Doc N°:

AMS02-PR-CGS-004

Ediz.:
Issue:

1

Data:
Date:

AUG 2007

Pagina
Page

17

di
of

34

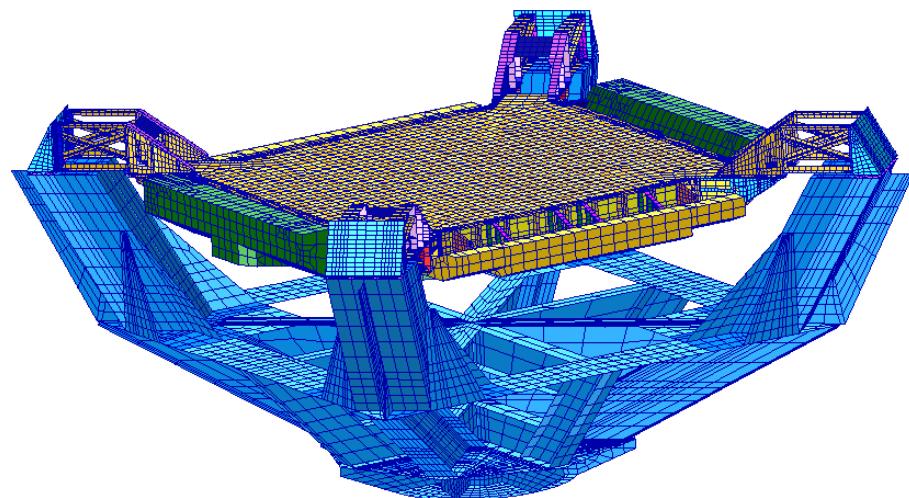


Fig. 10-2 Z Fixture

For the connection between UTOF and fixture an interface is used; the following figure shows the interface detail.

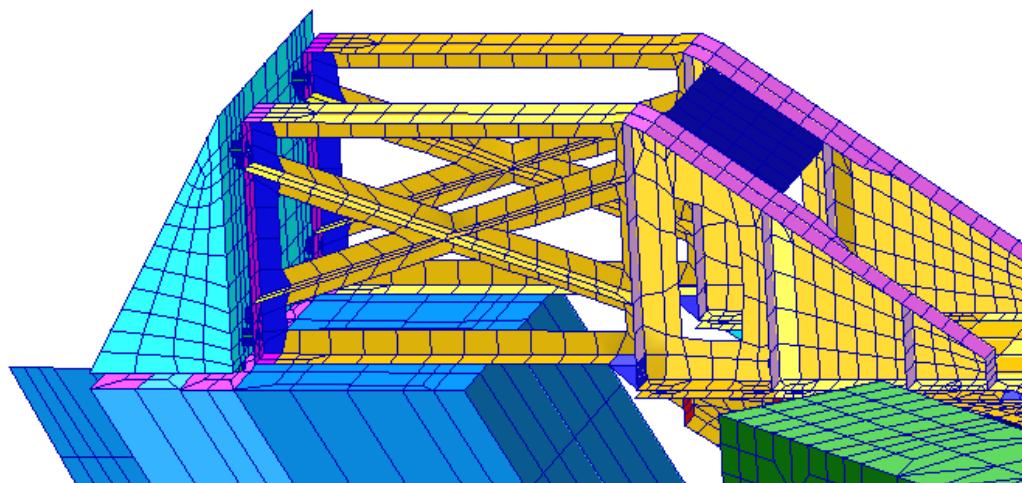


Fig. 10-3 UTOF-fixture connection detail

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02 <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°</i> : AMS02-PR-CGS-004 Ediz.: <i>Issue</i> : 1 Data: <i>Date</i> : AUG 2007 Pagina <i>Page</i> : 18 di <i>of</i> 34
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Fixture material is aluminum and Steel

The following bolts shall be used for installation :

JOINT	BOLT TYPE	TORQUE
Fixture to expander or sliding table	TBD by SERMS	TBD by SERMS
UUT interface to fixture	TBD by SERMS	TBD by SERMS
UUTfixture interface bolt (ref RD1 pag 63)	EWB 0420-5 A286-200 KSI Equivalent	30.5 Nm +/-8%
UUTfixture interface shear pin (ref RD1 pag 64)	Shear Pin nominal diameter 6.35 mm A286-160 KSI	NA

Tab. 10-1 INSTALLATION BOLTS AND TORQUES

X-Y FIXTURE MASS BUDGET	
ITEM	Estimated weight [kg]
TOTAL	168
Z FIXTURE MASS BUDGET	
ITEM	Estimated weight [kg]
TOTAL	734

Tab. 10-2 FIXTURE Mass budget (UTOF not included)



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:

Doc N°:

AMS02-PR-CGS-004

Ediz.:

1

Issue:

Data:
Date: **AUG 2007**

Pagina:

19

Page

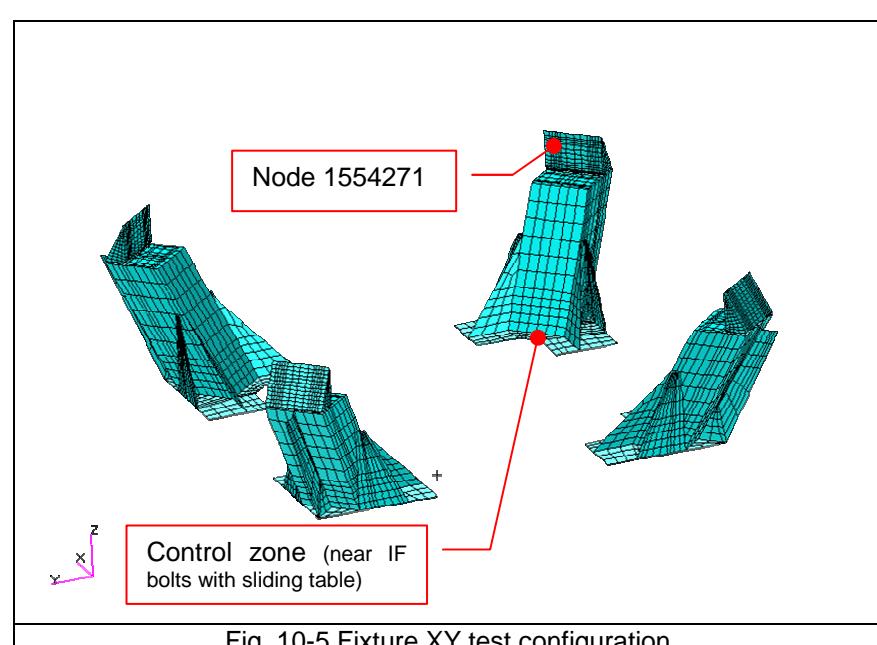
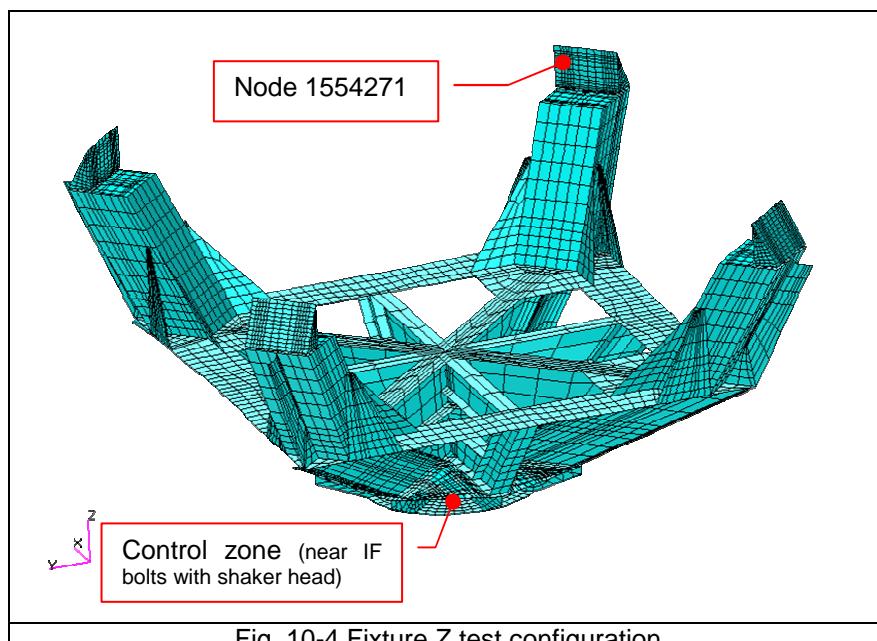
di
of **34**

10.2 FIXTURE TEST

A set of test results of the fixtures alone shall be provided by SERM before the UTOF vibration test. In particular the fixture shall be characterized with a sine sweep run where the shaker input at the fixture base was controlled. The frequencies of the fixture shall be measured and compared to the FEA predictions in order to allow the analytical correlation between the U-TOF hardmounted and fixture mounted first frequency.

The test shall be conducted both on the XY and Z Fixtures, however only the X direction shall be characterized for the Fixture XY for symmetry reasons.

The following figures show the tested configurations highlighting the node to be compared to the test results.



 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	<h1>AMS-02</h1> <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°:</i> AMS02-PR-CGS-004 Ediz.: <i>Issue:</i> 1 Data: <i>Date:</i> AUG 2007 Pagina <i>Page:</i> 20 di <i>of:</i> 34
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11.ACCELEROMETERS

The used accelerometers are type KS94.100/KS95.100 for control and KS94\KS95 for measure. The accelerometers datasheet and calibration status shall be annexed to the test report.

The accelerometers shall be placed using proper mounting adapters and means of mounting able to guarantee an accurate measurement in the range 5-2000 Hz. The current baseline is:

- Non sensitive surfaces to hard polishing:
 - Aluminum tape on surface
 - HBM Z70 cyanoacrilate glue with BCY01 accelerator to fix the sensor to the tape
- Sensitive surfaces to hard polishing:
 - Slightly abraded Kapton tape on surface
 - HBM Z70 cyanoacrilate glue with BCY01 accelerator to fix the sensor to the tape

Any modification of the UUT for accelerometers placement must be previously agreed with the UUT responsible\ls.

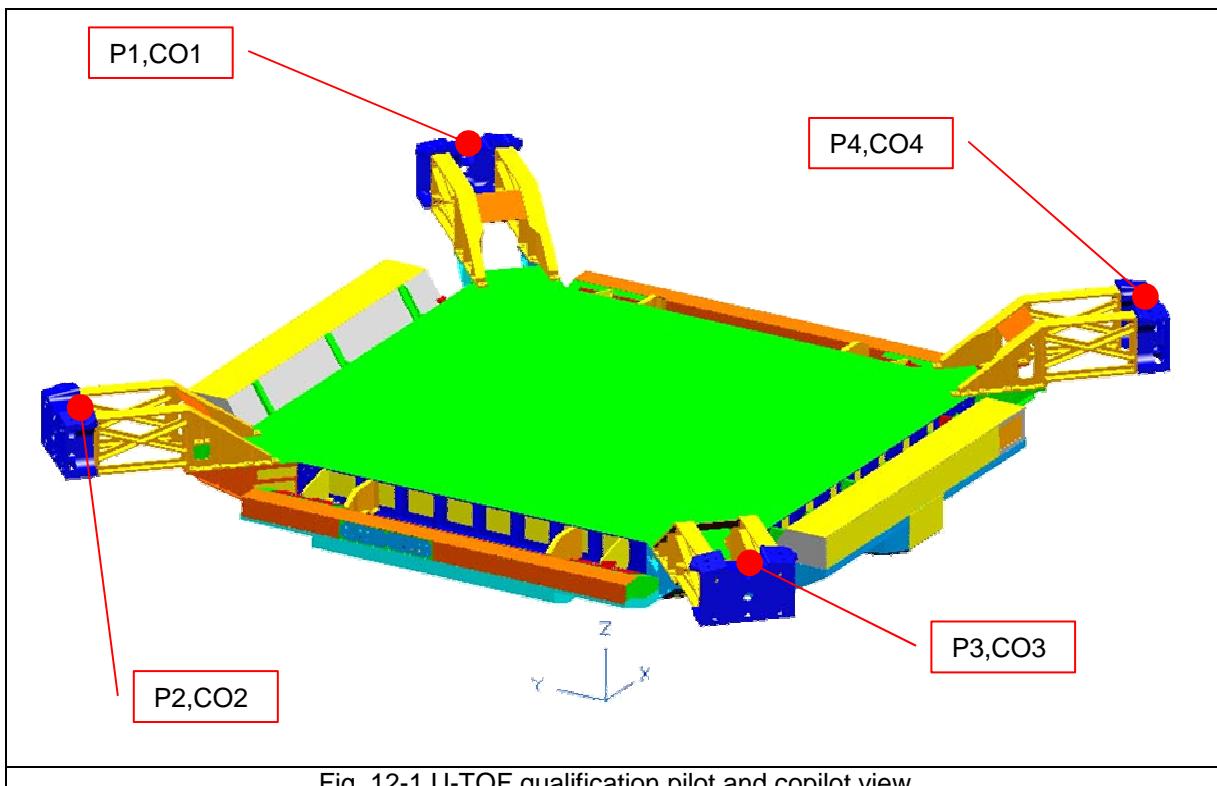
 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02 <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°</i> : AMS02-PR-CGS-004 Ediz.: <i>Issue</i> : 1 Pagina <i>Page</i> : 21	Data: <i>Date</i> : AUG 2007 di <i>of</i> 34
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12.INSTRUMENTATION PLAN

12.1 ACCELEROMETERS

The measurement accelerometers shall be placed in the locations defined hereafter:

Some accelerometers shall be placed inside the U-TOF, closing the PMT covers only with screws. After the vibration test the covers shall be removed, the accelerometers shall be removed, and then the covers shall be closed permanently with screws and epoxy. The next pictures show the open covers and the accelerometers locations:





CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:
Doc N°:

AMS02-PR-CGS-004

Ediz.:
Issue:

1

Data:
Date:

AUG 2007

Pagina
Page

22

di
of

34

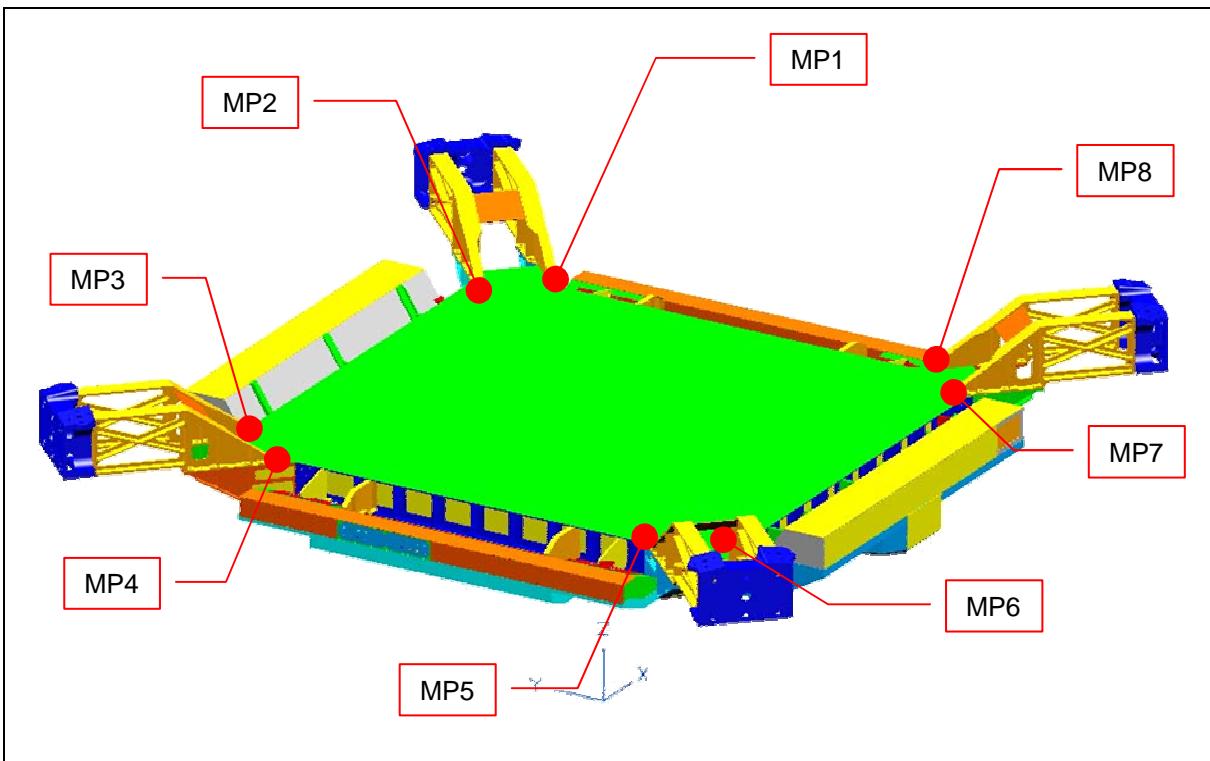


Fig. 12-2 U-TOF qualification measurement points view on Brackets

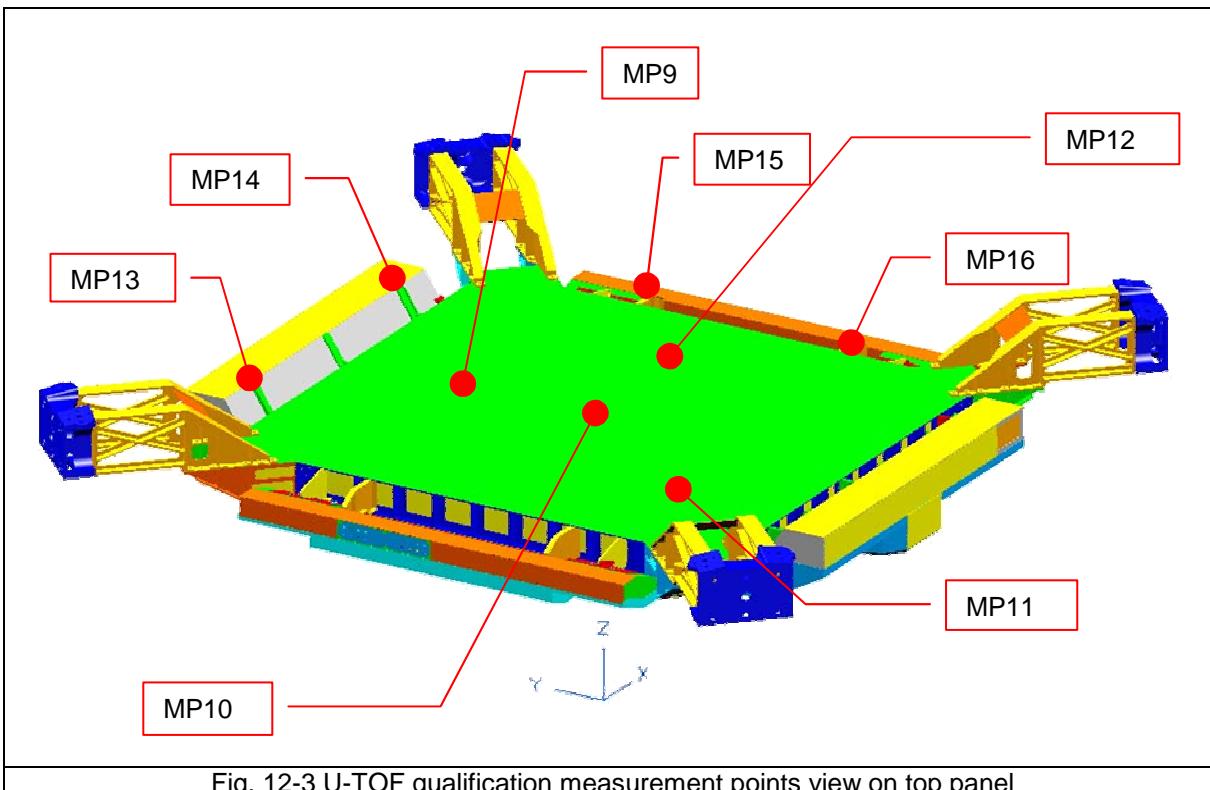


Fig. 12-3 U-TOF qualification measurement points view on top panel



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:
Doc N°:

AMS02-PR-CGS-004

Ediz.:
Issue:

1

Data:
Date:

AUG 2007

Pagina
Page

23

di
of

34

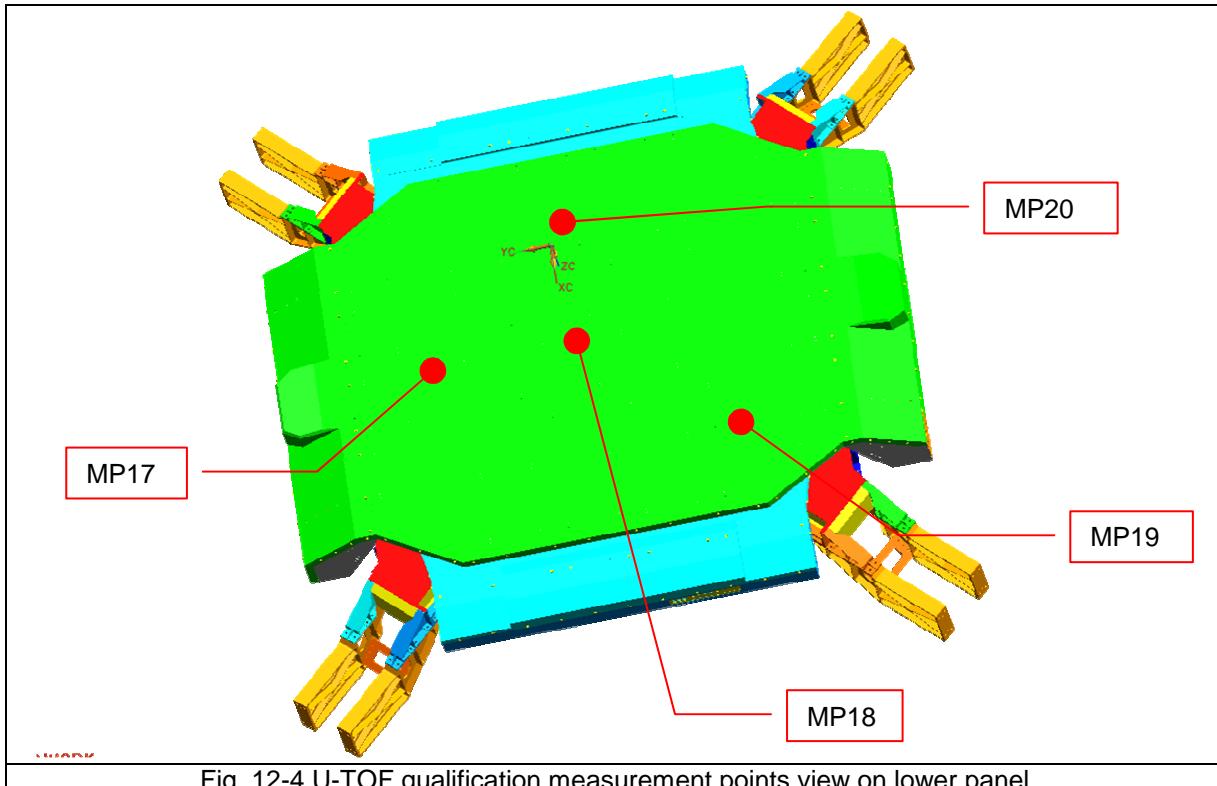


Fig. 12-4 U-TOF qualification measurement points view on lower panel

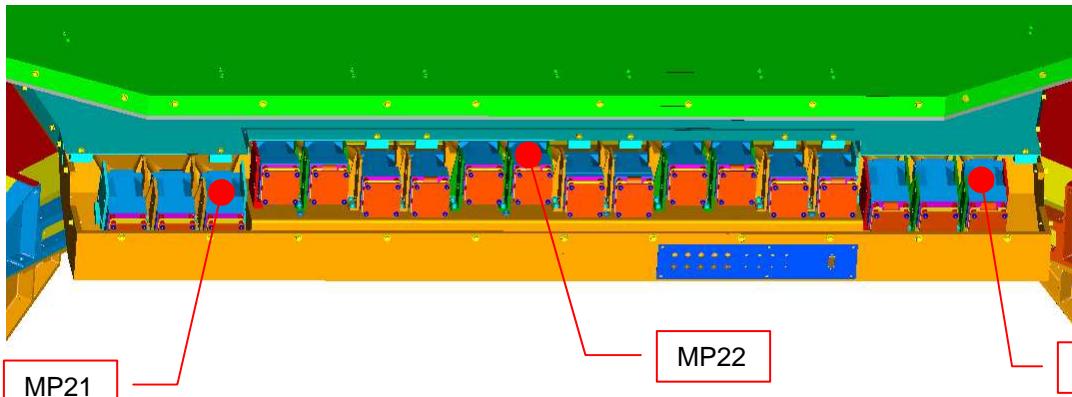


Fig. 12-5 U-TOF qualification internal measurement points view



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:
Doc N°:

AMS02-PR-CGS-004

Ediz.:
Issue:

1

Data:
Date:

AUG 2007

Pagina
Page

24

di
of

34

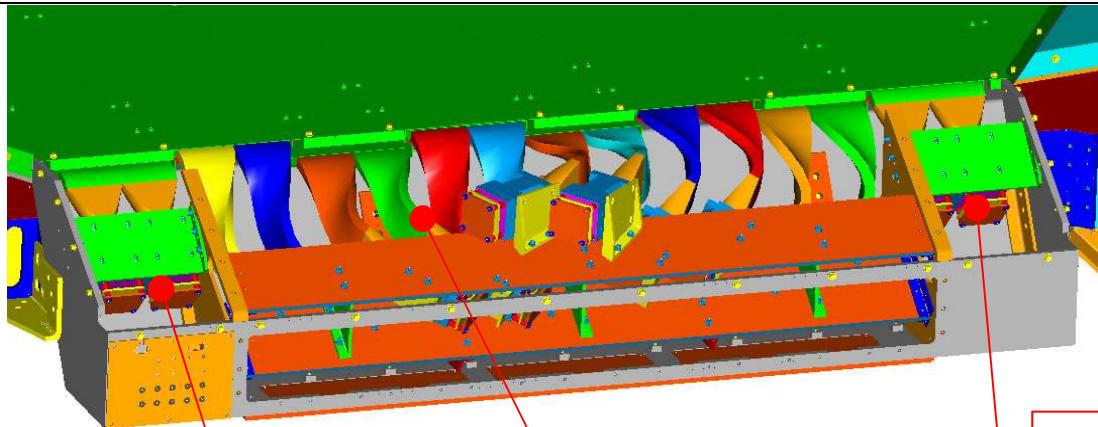


Fig. 12-6 U-TOF qualification internal measurement points view

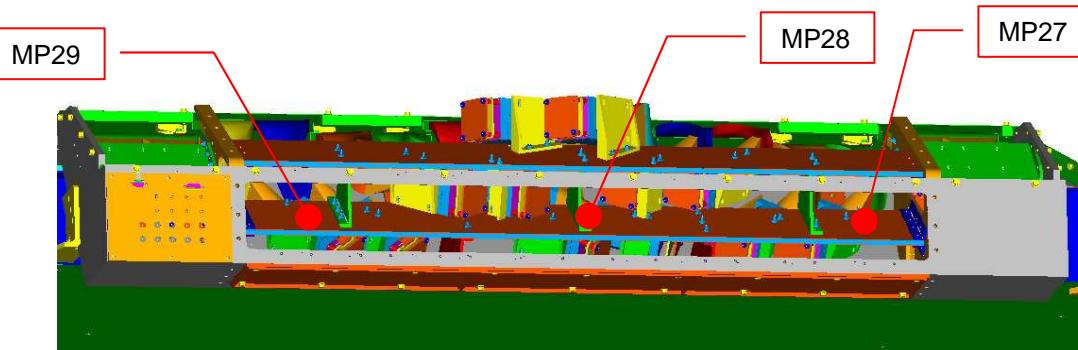


Fig. 12-7 U-TOF qualification internal measurement points view

 CARLO GAVAZZI SPACE SpA	<h1 style="text-align: center;">AMS-02</h1>	N° Doc: Doc N°: Ediz.: Issue: U-TOF VIBRATION TEST PROCEDURE	AMS02-PR-CGS-004 1 Data: AUG 2007 Pagina 25 di 34		

SENSOR	LOCATION	SENS. AXIS	REMARKS	CHANNELS	ACCEL. TYPE
P 1	U-TOF IF-1	exc. Axis	pilot	1	KS94.100 \ KS95.100
P 2	U-TOF IF-2	exc. Axis	pilot	1	KS94.100 \ KS95.101
P 3	U-TOF IF-3	exc. Axis	pilot	1	KS94.100 \ KS95.102
P 4	U-TOF IF-4	exc. Axis	pilot	1	KS94.100 \ KS95.103
CO 1	U-TOF IF-1	non exc. Axis	copilot	2	KS94 \ KS95
CO 2	U-TOF IF-2	non exc. Axis	copilot	2	KS94 \ KS95
CO 3	U-TOF IF-3	non exc. Axis	copilot	2	KS94 \ KS95
CO 4	U-TOF IF-4	non exc. Axis	copilot	2	KS94 \ KS95
MP 1	U-TOF BRACKET 11	X-Y-Z	measure	3	KS94 \ KS95
MP 2	U-TOF BRACKET 12	X-Y-Z	measure	3	KS94 \ KS95
MP 3	U-TOF BRACKET 21	X-Y-Z	measure	3	KS94 \ KS95
MP 4	U-TOF BRACKET 22	X-Y-Z	measure	3	KS94 \ KS95
MP 5	U-TOF BRACKET 31	X-Y-Z	measure	3	KS94 \ KS95
MP 6	U-TOF BRACKET 32	X-Y-Z	measure	3	KS94 \ KS95
MP 7	U-TOF BRACKET 41	X-Y-Z	measure	3	KS94 \ KS95
MP 8	U-TOF BRACKET 42	X-Y-Z	measure	3	KS94 \ KS95
MP 9	U-TOF TOP PANEL 1	X-Y-Z	measure	3	KS94 \ KS95
MP 10	U-TOF TOP PANEL 2 (CENTER)	X-Y-Z	measure	3	KS94 \ KS95
MP 11	U-TOF TOP PANEL 3	X-Y-Z	measure	3	KS94 \ KS95
MP 12	U-TOF TOP PANEL 4	X-Y-Z	measure	3	KS94 \ KS95
MP 13	U-TOF EXT-X 1	X-Y-Z	measure	3	KS94 \ KS95
MP 14	U-TOF EXT-X 2	X-Y-Z	measure	3	KS94 \ KS95
MP 15	U-TOF EXT-Y 1	X-Y-Z	measure	3	KS94 \ KS95
MP 16	U-TOF EXT-Y 2	X-Y-Z	measure	3	KS94 \ KS95
MP 17	U-TOF LOWER PANEL 1	X-Y-Z	measure	3	KS94 \ KS95
MP 18	U-TOF LOWER PANEL 2 (CENTER)	X-Y-Z	measure	3	KS94 \ KS95
MP 19	U-TOF LOWER PANEL 3	X-Y-Z	measure	3	KS94 \ KS95
MP 20	U-TOF LOWER PANEL 4	X-Y-Z	measure	3	KS94 \ KS95
MP 21	PMT 1	X-Y-Z	measure	3	KS94 \ KS95
MP 22	PMT 2	X-Y-Z	measure	3	KS94 \ KS95
MP 23	PMT 3	X-Y-Z	measure	3	KS94 \ KS95
MP 24	PMT 4	X-Y-Z	measure	3	KS94 \ KS95
MP 25	PMT 5	X-Y-Z	measure	3	KS94 \ KS95
MP 26	PMT 6	X-Y-Z	measure	3	KS94 \ KS95
MP 27	PMT 7	X-Y-Z	measure	3	KS94 \ KS95
MP 28	PMT 8	X-Y-Z	measure	3	KS94 \ KS95
MP 29	PMT 9	X-Y-Z	measure	2	KS94 \ KS95
	AVAILABLE	98	CURRENT	98	

pilot=control signal

copilot=monitor for cross axes

measure= measure of structure and internal electronics

Tab. 6-1 Measurement points table

 CARLO GAVAZZI SPACE SpA	<h1 style="text-align: center;">AMS-02</h1> <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: Doc N°: AMS02-PR-CGS-004 Ediz.: Issue: 1 Data: Date: AUG 2007 Pagina Page 26 di of 34
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13. INSTRUMENTATION, SPECIAL TOOLS AND TEST EQUIPMENT

The complete list of the instrumentation used during the test shall be recorded in Tab. 13-1.

The list shall be filled up during tests and reported in Test Report.

This list can be replaced by a "Declaration of Facility and Test Readiness", which summarizes the used test and measurement equipment in tabular form. The same declaration, including calibration and maintenance data, is later part of the finally summary test report.



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

Nº Doc: AMS02-PR-CGS-004
Doc. N°

Ediz.: 1 Data: AUG 2007
Issue: Date:

Pagina 27 di 34
Page 27 of 34

Tab. 13-1 Instrument list

(*) Where not specified the accuracy is as stated on the instrument manufacturer data sheet

 CARLO GAVAZZI SPACE SpA	AMS-02	N° Doc: <i>Doc N°:</i> AMS02-PR-CGS-004
	U-TOF VIBRATION TEST PROCEDURE	Ediz.: <i>Issue:</i> 1

Data:
Date:
AUG 2007

Pagina
Page
28 di
34

14. TEST LEVELS

14.1 RESONANCE SEARCH LEVELS

During resonance search the following level shall be used:

Linear frequency scan band:	5-2000 Hz
Scan speed	2 oct/min (sweep up only)
Level:	0.3 g (peak)
Control:	Multipoint input control is used with maximum strategy. Based on preliminary test results other possible control strategies shall be evaluated to provide the best test performance, according to requirements of chapter 5.

Tab. 14-1 Resonance search level

14.2 RANDOM VIBRATION LEVELS

The proposed baseline levels shall be applied according to the same procedure used for the LTOF. The monitored PMT accelerometers shall be verified and in case the measured gRMS levels shall exceed the limit of 6.8 gRMS a notching shall be applied.

JSC 28792, Rev. C				
Table 15-1: Maximum Expected Flight Levels for AMS-02				
X Axis	20-58 Hz	0.0025 g ² /Hz		
	58-125 Hz	+9 dB/Octave		
	125-300 Hz	0.025 g ² /Hz		
	300-900 Hz	-9 dB/Octave		
	900-2000 Hz	0.001 g ² /Hz		
	Overall = 3.1 Grms			
Y Axis	20-90 Hz	0.008 g ² /Hz		
	90-100 Hz	+9 dB/Octave		
	100-300 Hz	0.01 g ² /Hz		
	300-650 Hz	-9 dB/Octave		
	650-2000 Hz	0.001 g ² /Hz		
	Overall = 2.3 Grms			
Z Axis	20-45 Hz	0.009 g ² /Hz		
	45-125 Hz	+3 dB/Octave		
	125-300 Hz	0.025 g ² /Hz		
	300-900 Hz	-9 dB/Octave		
	900-2000 Hz	0.001 g ² /Hz		
	Overall = 3.2 Grms			
Note: MEFL Test duration: 60 seconds per axis				
Tab. 14-2 UTOF MEFL Random spectrum FROM AD1				



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

N° Doc:
Doc N°:

AMS02-PR-CGS-004

Ediz.:
Issue:

1

Data:

AUG 2007

Pagina
Page

29

di
of

34

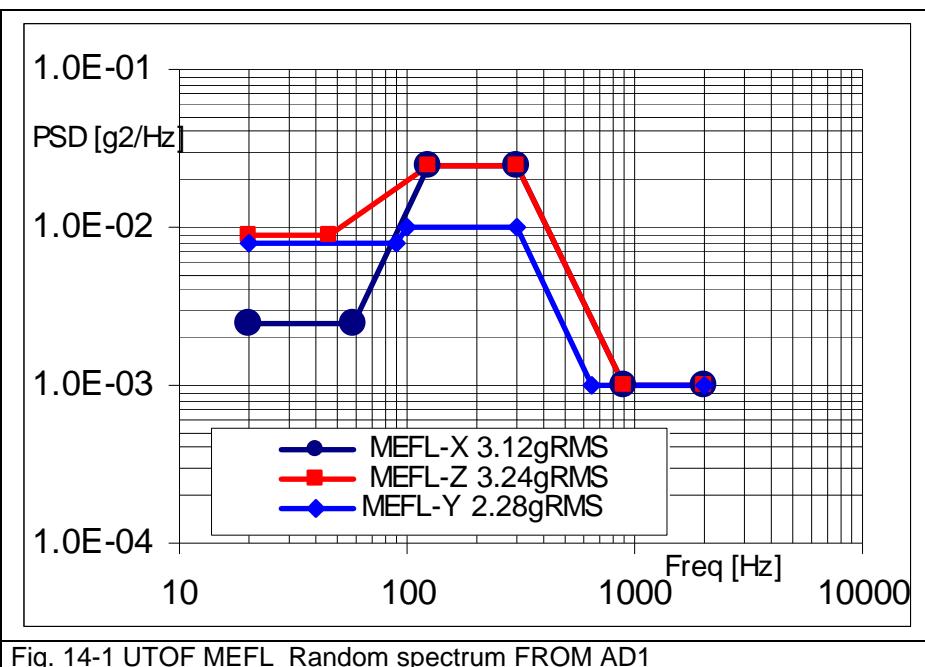


Fig. 14-1 UTOF MEFL Random spectrum FROM AD1

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02 <hr/> U-TOF VIBRATION TEST PROCEDURE	N° Doc: <i>Doc N°:</i> AMS02-PR-CGS-004 Ediz.: <i>Issue:</i> 1 Pagina <i>Page</i> 30 di <i>of</i> 34
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15. TEST PREDICTIONS AND NOTCHING APPROACH

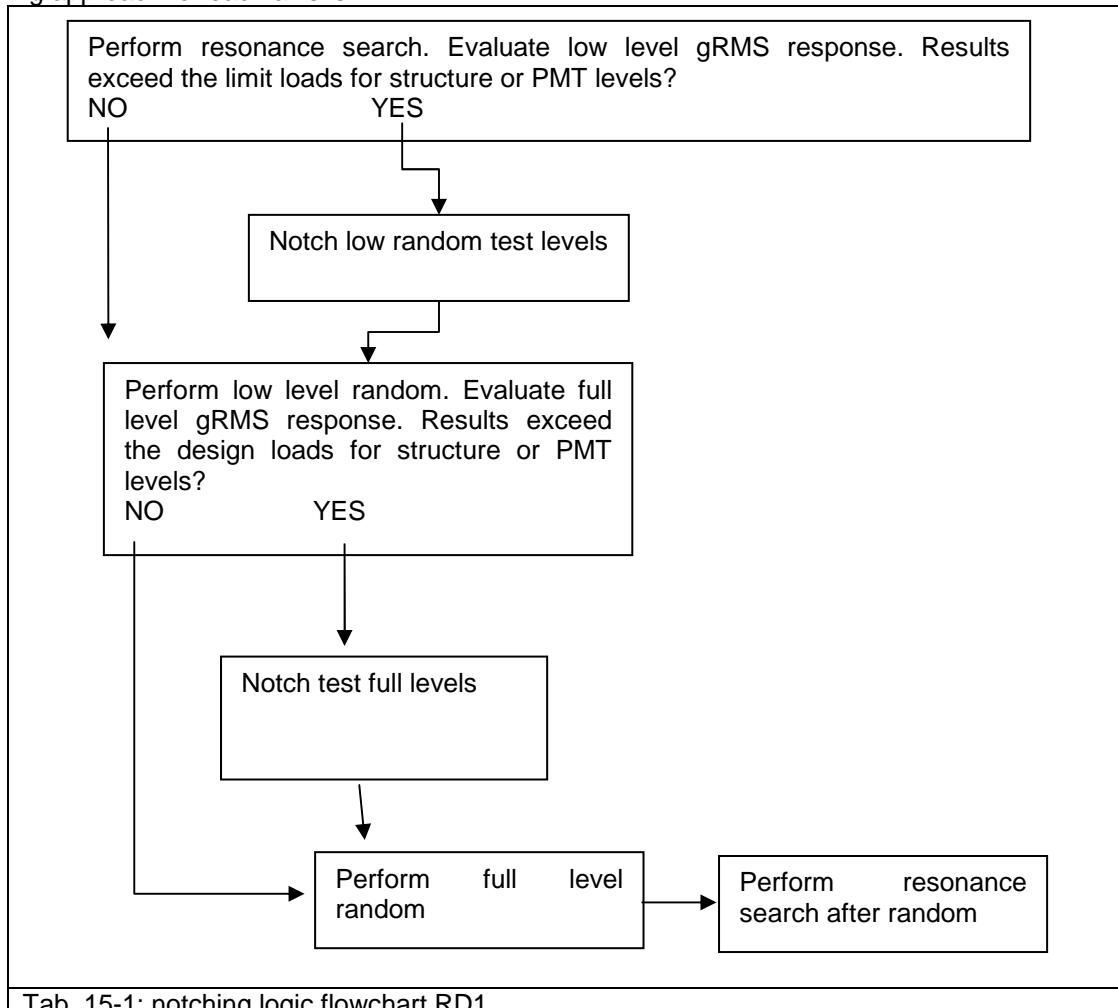
Notching shall be based both on analytical predictions and the measurements available during test. Notched levels and rationale used to derive them shall be recorded in a PVS datasheet.

15.1 NOTCHING PHILOSOPHY

During test if required a notching shall be implemented for the following scope:

1. not to exceed structural stress\force design levels
2. not to exceed at critical components level (PMT) their qualification levels.

The notching approach for each axis is:



Notched levels and rationale shall be recorded in a PVS datasheet.

 CARLO GAVAZZI CARLO GAVAZZI SPACE SpA	AMS-02 <small>U-TOF VIBRATION TEST PROCEDURE</small>	N° Doc: <i>Doc N°:</i> AMS02-PR-CGS-004 Ediz.: <i>Issue:</i> 1 Data: <i>Date:</i> AUG 2007 Pagina <i>Page:</i> 31 di 34
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15.2 NOTCHING FOR STRENGHT PURPOSES

For each run the gRMS response measured on **MP10**, the most representative point on the UTOF structure, shall be used and multiplied by the ratio COG\MP to evaluate the real acceleration at CoG during test:

	MP10\CoG ratio
X DIRECTION	1.24
Y DIRECTION	0.90
Z DIRECTION	0.22

Table 15-1 COG/MP ratio

According to RD2 , in case the calculated equivalent static test loads is exceeding the 1-sigma limits reported in the following table, a notching has to be evaluated to avoid structure overtesting.

	1-sigma acceleration Limits at CoG [gRMS]
X DIRECTION	23.66
Y DIRECTION	21.15
Z DIRECTION	3.4

Table 15-2 U-TOF acceleration limit values

The following figures show the central point behavior and the CoG response for each direction.

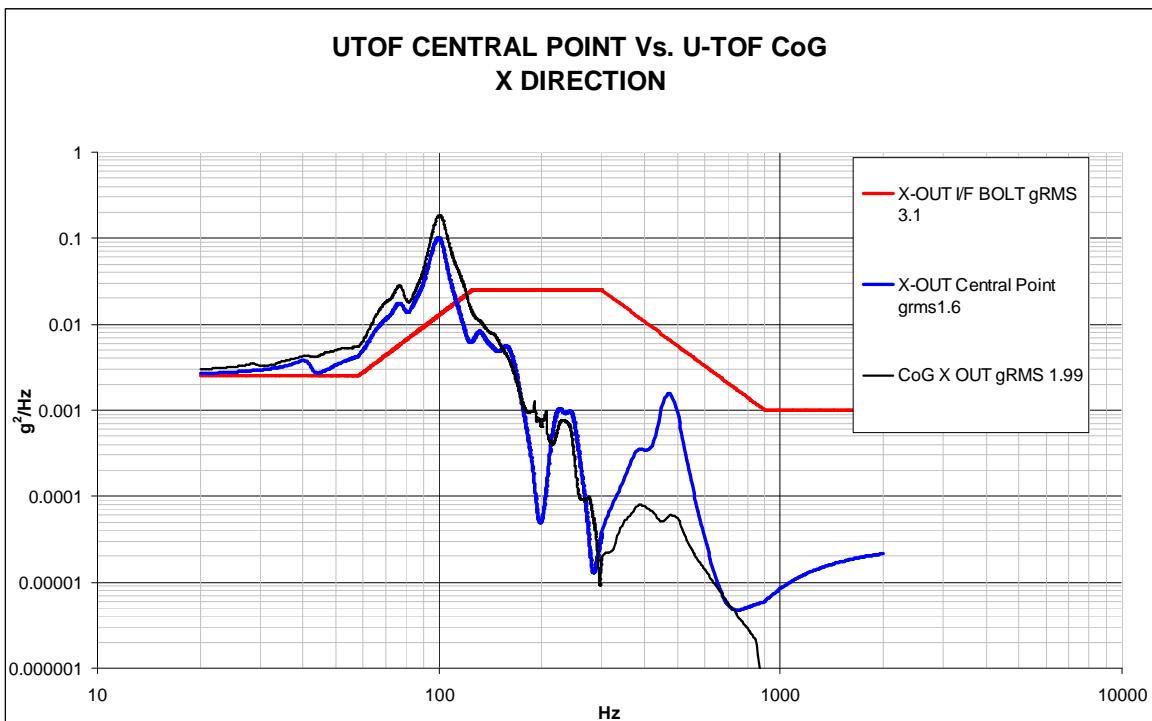


Figure 15-1 U-TOF central point Vs. U-TOF CoG – X-dir



CARLO GAVAZZI SPACE SpA

AMS-02

U-TOF VIBRATION TEST PROCEDURE

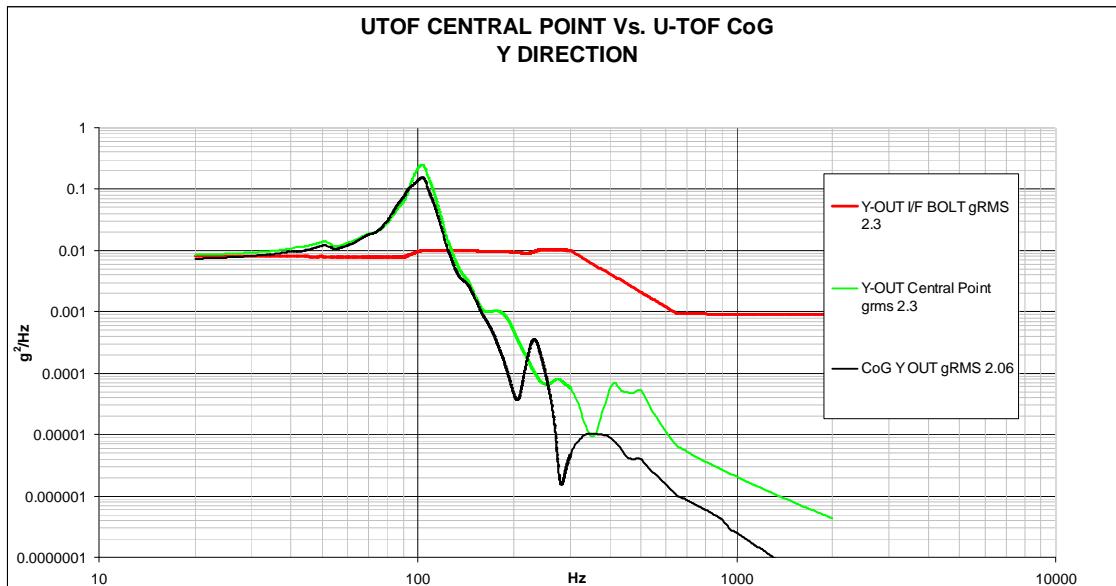
N° Doc:
Doc N°:**AMS02-PR-CGS-004**Ediz.:
Issue:**1**Data:
Date:**AUG 2007**Pagina
Page**32**di
of**34**

Figure 15-2 U-TOF central point Vs. U-TOF CoG – Y-dir

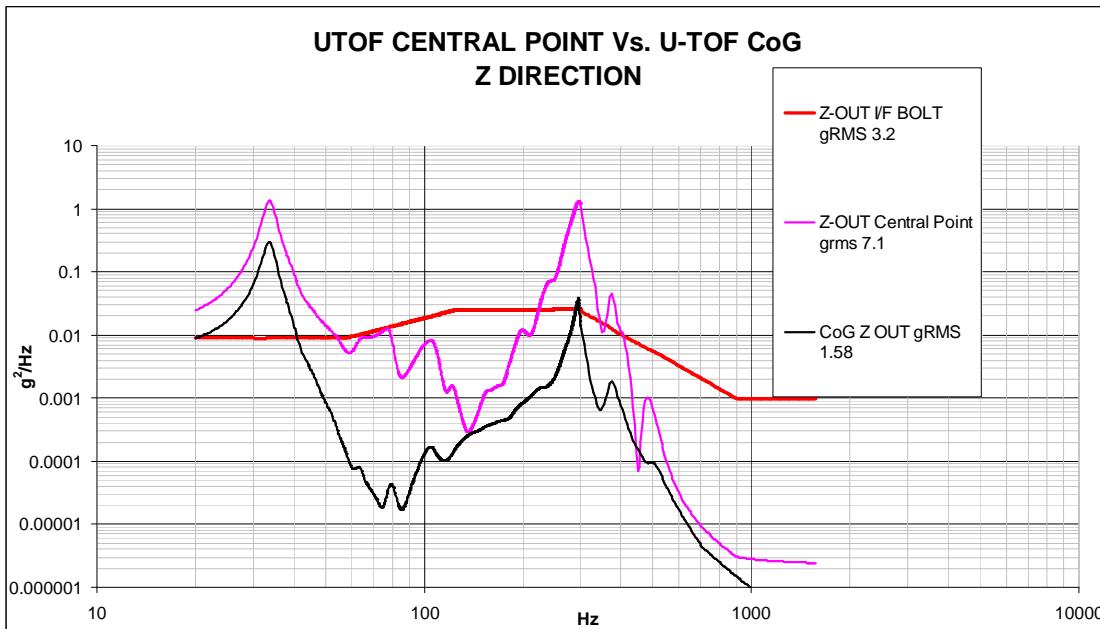


Figure 15-3 U-TOF central point Vs. U-TOF CoG – Z-dir

Based on the predictions of RD2 anyway no notching should be required for this purpose, considering the MEFL levels.

15.3 NOTCHING FOR COMPONENTS SPECIFICATION

Monitored components are the PMT's (MP 21-29) . Those components are qualified for a 6.8 gRMS 1sigma level. Therefore the input level shall be notched to guarantee that the measured channels shall not exceed this limit.

 CARLO GAVAZZI SPACE SpA	AMS-02	N° Doc: Doc N°: Ediz.: Issue: Pagina Page	AMS02-PR-CGS-004
	U-TOF VIBRATION TEST PROCEDURE		1 Data: AUG 2007 di of 34

16. TEST CONDITIONS

- The UUT shall be mounted on the vibrator exciter by bolting to the fixture.
- The transmissibility characteristic of the rigid fixture will guarantee that the input vibration levels are transmitted from the exciter to the UUT.
- Unless otherwise specified, all the measurements are to be performed at the following ambient conditions:
 - Temperature : $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$
 - Relative humidity : $60\% \pm 20\%$ RH
 - Pressure : Ambient
 - Cleanliness : visibly clean class
- During vibration on shaker it shall be considered acceptable to reach the following conditions
 - Temperature : $30^{\circ}\text{C} \pm 8^{\circ}\text{C}$
 - Relative humidity : $60\% \pm 30\%$ RH
 - Pressure : Ambient
 - Cleanliness : implementation of means to reduce contamination of the unit in a non visibly clean environment
- Laboratories General disposition shall be applied to maximize personnel safety from potential hazards.
- Skilled personnel shall be employed.
- All used instruments shall meet the necessary tolerances and shall not degrade the UUT performance:
 - for resonance search
 - Frequency : $\pm 2\%$
 - Sweep rate : $\pm 5\%$
 - Amplitude : $\pm 10\%$
 - for random vibration
 - Frequency : $\pm 5\%$ (or 1 Hz whichever is greater)
 - PSD : -1/+3 dB
 - Overall grms : $\pm 10\%$
- The accuracy of all the instruments shall be consistent with the tolerances for the variable to be measured, and should be at least one third of the tolerance itself.

17. TEST DATA SHEETS EXAMPLES

A typical step-by-step procedure sheets is provided in the following pages.

INFN can use the same structure, after CGS logo and disclaimer removal, to issue the official test procedure and report with pages signed by the INF personnel, according to the following instructions.

17.1 DATA SHEETS FILLING UP INSTRUCTIONS

The following fields of the data sheets:

- UUT DATA (including Model, Item, C.I., S/N)
- Measured value

Shall be filled up during the test performances and shall be part of the Test Report together with photographs, sketches, etc. eventually useful to document the test execution/result.

Remarks field shall be used as a minimum to provide, where appropriate, reference to PVS.

Test Report reference data shall be added in the relevant field.

Each data sheet (including the attachments) shall be certified with the Test Conductor signature and date.

 CARLO GAVAZZI SPACE SpA	<h1 style="text-align: center;">AMS-02</h1>	N° Doc: Doc N°: AMS02-PR-CGS-004	N° Doc: Doc N°:
		Ediz.: 1 Data: AUG 2007	Ediz.: 1 Data:
	U-TOF VIBRATION TEST PROCEDURE	Pagina Page 34 di of 34	Pagina Page di of
TEST PROCEDURE REFERENCE			TEST REPORT REFERENCE

UUT DATA :		Model	Item	C.I.	S/N
STEP n°	TEST SEQUENCE			EXPECTED VALUE	MEASURED VALUE
1.	xxx				
1.1.	XXX				
1.2.	XXX				

2.	xxx			
2.1.	XXX			
2.1.1.	XXX			

DATE:	TEST CONDUCTOR	QA	CUSTOMER
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